Cerebrovascular Mortality 10 Years After Stroke
A Population-Based Study
Andreas Terent, MD, PhD

Objectives—Cerebrovascular mortality has declined in the general population of Sweden. The objective of the present study was to investigate causes of death among stroke patients in a long-term perspective.

Research Design and Methods—A population-based study was conducted of first-ever strokes in the municipality of So¨derhamn, Sweden. Standardized mortality ratios were calculated for comparison with the general population. Three time periods (1975 to 1978, 1983 to 1986, and 1987 to 1990) were analyzed. All 1186 patients were followed up for at least 10 years.

Results—Cerebrovascular mortality was greatly increased (more than 10-fold) in comparison with the general population during all study periods. The mortality from ischemic heart disease and some other diseases was moderately raised (3- to 8-fold), whereas the mortality from malignant disorders was normal.

Conclusion—Cerebrovascular disease was the predominant cause of death among Swedish stroke patients in the 1970s and the 1980s. (Stroke. 2004;35:e343-e345.)

Key Words: cardiovascular ☐ mortality ☐ cause of death ☐ stroke

Stroke mortality has declined in many countries, including Sweden.1,2 This decline is attributable to a reduction in short-term fatality rather than to a decrease in stroke events.3 Cause-specific mortality data representing at least 4 years of follow-up have been presented for some stroke cohorts4–6 but are still lacking for Sweden.

In the population of So¨derhamn, both stroke incidence rates and short-term case fatality rates for stroke have been relatively constant.7 In contrast, the long-term case fatality rates have decreased over the years, particularly among the oldest patients.7 These data might indicate that many stroke patients die of other causes rather than the primary event. The aim of the present study was to determine whether cerebrovascular mortality has changed in the So¨derhamn stroke cohort.

Subjects and Methods
First-ever strokes, both hospitalized and nonhospitalized patients, were registered as described in detail previously.7 All 1186 patients were followed up for at least 10 years. All deaths in this cohort were registered prospectively because the register nurse checked the patient’s vital status at regular intervals. All death certificates for deceased patients were requested from the National Bureau of Statistics in Stockholm. Patients were identified by their 10-digit personal identification numbers, which are unique for every Swedish citizen.

The National Bureau of Statistics coded death certificates according to the International Classification of Diseases (ICD)-8 and ICD-9 classifications. Only deaths occurring within 10 years of follow-up are presented in the present article. ICD code number specifications of the cerebrovascular and other diseases registered as causes of death are shown in Table 1.

The standardized mortality ratio (SMR) for each cause of death was calculated as described by Rothman.8 The SMR is the ratio of the observed to the expected number of deaths. The expected number of deaths was obtained by multiplying the death rate in the Swedish population by the number of person-years at risk in the stroke cohort. For each cohort member, person-years at risk by age group and calendar year were calculated. The death rate of 1978 was used for patients who entered the stroke register from 1975 to 1978. Correspondingly, the population death rates of 1987 and 1991 were chosen for patients who entered the stroke register from 1983 to 1986 and 1987 to 1990.9 Confidence limits for the SMR were calculated at 95%, according to Schoenberg.10

The Ethics Committee for Clinical Research at Uppsala University approved this study.

Results
During the study years, 1186 patients with first-ever stroke were entered into the local stroke register. A total of 895 (75.5%) of the patients died within 10 years. No patients were lost to follow-up. Cardiovascular death accounted for 639 (71.4%) of the deaths, cerebrovascular disorders 38.2%, and ischemic heart disease 33.2% (Table 1).

The SMRs are given in Table 2. For all causes of death, the mortality was 3 to 10 times higher than that in the general population. The mortality from cerebrovascular disorders was greatly increased (more than 10-fold), whereas the mortality from ischemic heart disease was
moderately increased (3- to 8-fold). The risk of dying from malignant disorders was normal. For some other disorders, the mortality was moderately raised (2- to 5-fold). For both cerebrovascular and cardiovascular disorders, the highest SMRs were found among the patients who had their stroke in the first time period, 1975 to 1978.

Discussion
Cardiovascular disorders caused 71% of the deaths among the stroke patients in the present study. This frequency has varied between 29% and 68% in previous investigations.4–6 The variations may be explained by use of different methods for estimating the cause of death. The highest figure, 68%, was reported from the WHO MONICA study from Copenhagen County.4 In that study, ICD codes from death certificates were used,4 whereas the other 2 were based on other sources of information.5,6 Usually the WHO MONICA studies comprise patients aged 35 to 64 years,3,11 but the Copenhagen study was an exception, including patients aged 25 years and older.4 In Copenhagen, the mortality from cerebrovascular causes was 8 to 9 times higher than that in the general population, whereas in Söderhamn, it was more than 10 times higher. However, SMRs from different cohorts are not comparable with each other.8 Accordingly, it is also false to compare the SMRs from different time periods in the Söderhamn cohort.8 Conversely, it is justified to compare SMRs for different causes of death from the same exposed group. In relation to the general population, cerebrovascular disease is the predominant cause of death after first-ever stroke in all periods, whereas ischemic heart and other diseases, except for malignant disorders, have a moderate impact on the death rate in all periods. The very high SMR for cerebrovascular disease before age 75 was not caused by a higher short-term case fatality in this group compared with the group of older patients.7

Both in the present and in previous studies, the Söderhamn stroke cohort has been divided into 3 time periods: 1975 to 1978, 1983 to 86, and 1987 to 1990.7 This division is justified from a diagnostic and therapeutic point of view. Computed tomography was performed in 1% of the patients in the first period, 38% in the second period, and 61% in the third. An acute stroke unit was opened during the second period and new rehabilitation facilities during the last one. These changes may have had an impact on the mortality caused by the primary stroke event as well as on that caused by recurrent stroke. However, cerebrovascular disease is the predominant cause of death in the Söderhamn stroke cohort during all time periods.

Acknowledgments
The County Council of Gävleborg, Sweden, supported this study. My sincere gratitude to the staff of the Department of Medicine at the Hälsoingland (formerly Söderhamn) Hospital, and especially to
the stroke research nurses Ingrid Westerberg, RN (1975–1979), and Pirjo Pettersson, RN (1983–2001), for data collection and follow-up.

References
Cerebrovascular Mortality 10 Years After Stroke: A Population-Based Study
Andreas Terént

Stroke. 2004;35:e343-e345; originally published online May 13, 2004;
doi: 10.1161/01.STR.0000129333.87858.4f
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2004 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/35/7/e343

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org/subscriptions/